METHOD OF TEST DETERMINING THE ASPHALT CONTENT OF BITUMINOUS MIXTURES BY THE NUCLEAR METHOD

SCOPE

This method of test is for determining the asphalt content of bituminous mixtures with a gauge that utilizes a radioactive sealed source of americium-beryllium. The use of this gauge must be in accordance with the radiation regulations of the Iowa Department of Health.

OPERATOR QUALIFICATIONS

Operators must comply with I.M. 206, Nuclear Test Equipment.

PROCEDURE

A. Apparatus

1. Troxler Model 3241-B Asphalt Content gauge, having a 11.1 G. Becquerel (300 mCi) sealed source of Am241:Be

   NOTE 1: This gauge has a microprocessor that controls the operation of the gauge, calculates the slope and intercept of each calibration and leads you through each operation procedure.

2. 4 sample pans

3. Oven for heating and drying

4. Thermometer, 38-204°C (100-400°F)

5. Balance with at least 10,000-gram capacity and accurate to 1 gram

6. Scoop and spatula

7. Plywood 20 mm (¾ in.) or thicker that has dimensions slightly larger than the sample pan.

8. Nuclear Gauge Manufacturer Instruction Manual

B. Statistical Stability Test

1. The following situations require a statistical stability test to be performed:

a. After not being used and in storage for more than one month

b. Five (5) percent or more variation of the daily background count from previous background count taken at the same location

NOTE 2: Iowa DOT experience with the 3242-B has shown that the variation of the daily background rarely exceeds 10 counts, or approximately 0.5 percent of the background count. This suggests that the statistical stability test should be run when a daily variation of more than 10 is observed.

c. The gauge is moved to another location.

d. Monthly, as part of the routine check of the equipment.

2. Turn on the gauge, and allow its electronics to stabilize (about 2-3 minutes).

3. Follow the operation flow diagram in the manufacturer manual and determine the stability test.

4. The gauge will automatically take 20 one-minute counts and display a result as either pass or fail.

5. Refer to the manufacturer manual and follow the instructions when the gauge fails the stability test.

C. Background Count

1. Determine a background count each day prior to calibrating or testing.

2. Stabilize the gauge electronics as done in B2.

3. Refer to the manufacturer manual, follow the operation flow diagram and determine the background count.

4. Determine a 16-minute background count for calibration and for testing.

NOTE 3: The gauge drawer must be empty and closed when determining a background count.

5. The gauge will automatically record and store the background count.

D. Calibration

1. Follow the steps in Test Method Iowa 504, Aggregate Preparation, Batching and Mixing for Asphaltic Concrete Trial Mixes, or I.M. 510, Method of Design of Asphalt Concrete Mixtures, and prepare at least two 8000 gram batches. The aggregate and asphalt for these batches must be identical to that used for the project mix which is to be tested. One of these batches should have an asphalt content that is approximately 1% above and the other approximately 1% below the intended asphalt content of the project mix.

   NOTE 4: A minimum of two samples is used in the calibration of the gauge. However, the accuracy of the test is increased by using more than two samples for calibrating. The gauge manufacturer experience indicates the number of samples used for calibrating should be from three to five.

2. Weigh the sample pan and record the weight to the nearest 1 gram.

3. Place the prepared mix into the sample pan immediately after mixing until the pan is α-full.

4. Lift the pan about 25 mm (1 in.) and tap it on a firm surface such as a counter top.

5. Lightly tamp the sample with the spatula or scoop.

6. Repeat steps D3, D4 and D5 until the sample pan is slightly overfull.

7. Use the spatula and level the top of the mix in the sample pan, moving the mixture to the edges of the pan.

8. Place the piece of plywood on top of the sample and press down to compress the material to the top edge of the sample pan.

9. Weigh the sample and pan to the nearest 1.0 gram. Subtract the weight of the pan obtained in step D2 from this weight and record the actual sample weight.

10. Obtain the temperature of the sample by inserting the end of the thermometer into the center of the sample, which is contained in the sample pan.

11. Place the sample in the gauge, record the sample temperature into the gauge microprocessor and obtain a 16-minute calibration count as described in the operation flow diagram in the manufacturer manual.

12. The gauge will automatically record the calibration count.

13. Repeat the above steps and determine the calibration count for the sample having the other asphalt content. The weight and temperature of this sample must be the same as the previous sample as determined in Step 9.

NOTE 5: The slope and intercept of the calibration line is automatically calculated by the gauge microprocessor. The data that is necessary for this calculation is: calibration background count, the counts and temperature of the calibration samples.

14. Assign a reference number to identify this calibration data for future use.

NOTE 6: The gauge has a memory capable of storing 45 calibrations. The above calibration data may be stored in the gauge memory.

E. Sample Test

1. Determine a 16-minute background count in the same manner as in C3.

2. Follow I.M. 357, Method of Preparation of Bituminous Mix Samples for Test Specimens, and obtain a test sample of the same weight as the calibration samples in Step D9.

3. Prepare the sample for testing by following steps D3 through D10.

4 Recall the appropriate calibration data from the gauge memory or manually enter it in the microprocessor.

5. Place the test sample in the gauge, enter the test sample's temperature into the gauge microprocessor and obtain a four-minute count.

6. The percent asphalt in the test sample is automatically calculated and displayed by the gauge.

F. Transferring a Calibration to Another Gauge

NOTE 7: When a calibration determined in one gauge is used in another gauge for sample testing or correlation testing, the calibration slope and intercept must be adjusted to account for differences in measurement characteristics inherent to each individual gauge and its operating environment. Gauge counts on transfer pans are used to calculate the adjusted calibrations.

Definition: Transfer pans are, five 7100-gram asphaltic concrete mix samples prepared from standard materials and having asphalt contents of 4, 5, 6, 7 and 8 percent. Each sample is sealed with epoxy to prevent moisture content change. Each pan is marked with its asphalt content.

1. With the gauge in the stability test mode determine, at room temperature, the average of 20 one-minute counts for each pan. Each result is the transfer count for the appropriate pan. These transfer counts should be verified at least once a year.

Example:

Transfer Pan No.	Gauge A Counts	Gauge B Counts
1 (4% AC)	CA_1 = 1674	CB_1 = 1710
2 (5% AC)	CA_2 = 2150	CB_2 = 2190
3 (6% AC)	CA_3 = 2626	CB_3 = 2670
4 (7% AC)	CA_4 = 3102	CB_4 = 3150
5 (8% AC)	CA_5 = 3578	CB_5 = 3630

2. Calibrate the mix in the first gauge (A) as described in Steps D1-D13 to provide the following calibration data:

   Slope = S cal
   Intercept = I cal
   Background = B cal
   Calib. Temp. =°C (°F)

3. Select two transfer pans whose asphalt content and counts will best encompass the target asphalt content and counts. Use the appropriate transfer counts as determined in Step 1 for the calibration gauge and the sample testing gauge.

4. Determine the calibration for transfer to the testing gauge (B) by performing the following calculations:

   New slope for Gauge B

   $$S_B = S_{cal} \quad \frac{CA_x - CA_y}{CB_x - CB_y}$$

   Where: CA_x & CA_y represent counts on the transfer pans for the mix calibration gauge above and below the intended asphalt content respectively. CBx and CBy are testing gauge counts for the same two transfer pans.

   New intercept for Gauge B

   $$I_B = (S_{cal} \times CA_x) - (S_B \times CB_x) + I_{cal}$$

5. Enter these slope and intercept values into the testing gauge and proceed to test mix samples for AC content as described in Step E.

6. Example Calculation for Transfer of Calibration from Gauge A to Gauge B.

   Mix design Data ABD6 - 175
   Calibrated on Gauge A.

   @ 4.5% AC 16 min. calib. count = 2245
   @ 5.5% AC 16 min. calib. count = 2492
   @ 6.5% AC 16 min. calib. count = 2738

NOTE 8: S in as displayed by the gauge is slope multiplied by 1000.

S_{cal} = 0.00406
I_{cal} = -4.61
B_{cal} = 1645
T = 121.1°C (250°F)

- Recommended AC content of 6.1%
- @ 6.1% AC, counts approximately 2640

Select transfer pan counts for gauge A and B from Step 1 which encompass target value.

Use CA_3 = 2626 CB_3 = 2670
CA_4 = 3102 CB_4 = 3150

Calculation of Gauge B Calibration Slope and Intercept.

$$S_B = 0.00406 \frac{(3102 - 2626)}{(3150 - 2670)} = 0.00403$$

$I_B = (0.00406 \times 3102) - (0.00403 \times 3150) + (-4.61)$

$I_B = -4.71$

G. Verification of Calibration Accuracy

NOTE 9: When a calibration has been transferred from the Central Lab to a Transportation Center, a degree of error is introduced, primarily due to differences between mix design materials and field production materials. The most accurate procedure is for the Transportation Center Laboratories to calibrate their own mixes. If a transferred calibration is used in lieu, a Transportation Center calibration, the following verification procedure should be performed to assure the user of its accuracy.

1. Obtain asphalt and cold feed samples from the plant site for the project mix which the calibration will be used to monitor. Enough material should be obtained to make three 8000 gram batches of asphalt concrete at or near the intended asphalt content.

2. Prepare an 8000 gram batch of asphalt mix at a known asphalt content by following the steps in Test Method Iowa 504, Aggregate Preparation, Batching, and Mixing for Asphalt Concrete Trial Mixes, or I.M. 510, Method of Design of Asphalt Concrete Mixtures. The intended AC content indicated by the mix design should be used for this step.

3. Using the transferred calibration being investigated for accuracy, determine asphalt content of the mix sample by nuclear method according to I.M. 335, Section E.

4. If the nuclear asphalt content result is within 0.10% of the actual content, the calibration can be considered valid.

5. If the result is not within 0.10%, a new calibration should be established by using the remaining two 8000 gram cold feed samples to prepare two more asphalt points. The first point (Step 3), plus these two additional points, can be used to establish a new three-point calibration in accordance with I.M. 335, Section D.

H. Reporting

1. Record the percent asphalt the gauge displayed to two (2) decimal places on a report.

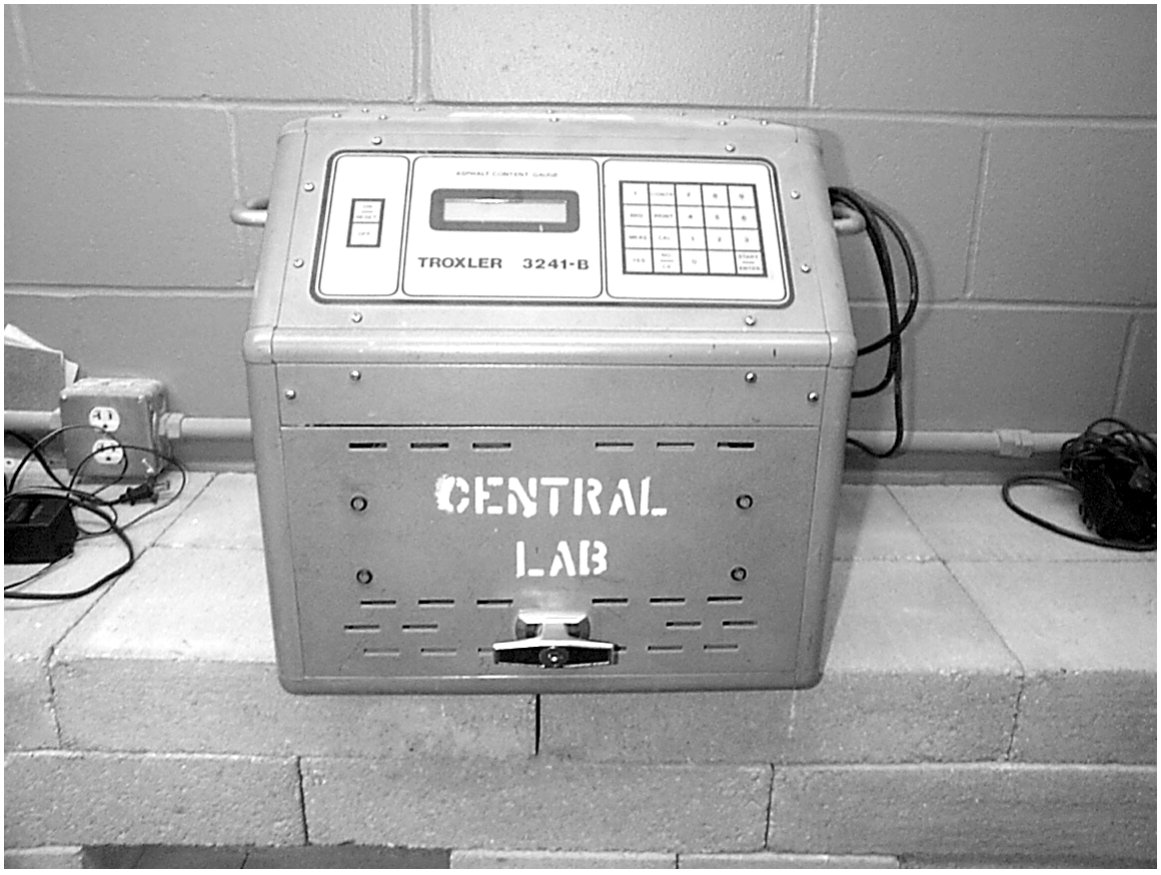

Figure 1. Asphalt Content Gauge